URBAN SPRAWL IN DESERT CITIES: THE CASE STUDIES OF PHOENIX, ARIZONA AND RIYADH, SAUDI ARABIA

A RESEARCH PAPER

SUBMITTED TO THE GRADUATE SCHOOL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE

MASTERS OF URBAN AND REGIONAL PLANNING

BY

HAMAD N. ALSAIARI

DR. ERIC D. KELLY - ADVISOR

BALL STATE UNIVERSITY

MUNCIE, INDIANA

JULY 2010

Abstract

The growth of the world's cities is unavoidable as long as the population continues to increase. However, it is important that these cities grow and develop in a responsible manner in order to avoid harmful urban sprawl. Sprawl is problematic because it is unsustainable. Urban sprawl leads to unnecessary expenses, rapid use of resources, including limited land space, and environmental problems. Sprawl within the desert regions is particularly problematic due to their lack of resources and the artificial environment they currently necessitate.

Here two comparable, however, culturally dissimilar desert cities are compared and analyzed to better understand desert city sprawl and how it is dealt with in hopes of obtaining knowledge that can be later applied to the development of solutions. It is determined through this analysis that urban sprawl, particularly in desert cities, will most likely continue in their problematic nature until laws and policies are developed and public mindsets changed to make desert living more compatible with the surrounding environment.

Table of Contents

Acknowledgment…… II

List of Figures…… V

List of Tables…… VI

Abstract…… VII

Introduction…… 1

Background on Sprawl…… 3

Causes of Sprawl…… 3

Social Causes…… 3

Economic Causes…… 4

Political Causes…… 5

Effects of Sprawl…… 6

Positive Effects…… 6

Negative Effects…… 6

Sprawl in Desert Regions…… 8

Fighting Sprawl…… 9

The Case Study of Phoenix…… 12

Growth From 1870-1970…… 12

Growth From 1970-Today…… 15

Sprawl in Phoenix…… 17

High Automobile Dependency…… 17

Excessive Annexation……. 17

Socio-economic Factors…….. 18

Planning Policies……. 21

The Case Study of Riyadh…… 27

History from 1900-1950…….. 27

History from 1950-1970…….. 29

History 1971-Present…….. 32

Sprawl in Riyadh……. 36

Land Grant Practice…… 36

Real Estate Development Fund…… 37

Privacy…….. 38

Car Dependency…….. 38

Planning Policies……. 39

Analysis and Findings……... 44

Case Study Comparison…….. 44

Lessons Learned…….. 46

Conclusion…….. 50

Bibliography……... 52

List of Figures

Figure 1: Growth in Phoenix metropolitan area between 1955 and 1995…… 14

Figure 2: Growth in Phoenix over the years……. 16

Figure 3: Social segregation in different parts of the city of Phoenix…….. 20

Figure 4: The Urban Village concept……... 23

Figure 5: Targeted urban growth areas in the city of Phoenix……..… 24

Figure 6: Old Riyadh was a walled town……..… 28

Figure 7: Almalaz Neighborhood, which is considered the turning point for urban form…… 30

Figure 8: Riyadh's urban growth nodes in the 1950s…….. 31

Figure 9: The first plan for Riyadh prepared by Doxiadis Associates in 1971…...… 33

Figure 10: The second plan for Riyadh prepared by SECT Intl. in 1982……...…… 34

Figure 11: Arial photos for urban growth in Riyadh between 1972 and 2000…...… 35

Figure 12: Rendering of the future decentralized sub-centers in Riyadh……...… 40

Figure 13: Decentralizing approach through sub-centers and satellite towns…...…. 41

Figure 14: Riyadh's plan showing the urban development limit of 2021……..… 43

List of Tables

Table 1: The city of Phoenix demographics in different zip codes in 2008……. 19

Table 2: Riyadh's urban indicators……...…… 36

Acknowledgment

Praise be to God, and thanks go to those who supported and assisted me throughout this work. I owe a great deal of appreciation for my supervisor Dr. Eric D. Kelly for his continuous guidance and constructive comments in writing this paper. I extend my appreciation to Micah Rainwater for taking the time to proofread my paper several times. Finally, I wish to express my gratitude to my family for their support, love, and prayers throughout my entire life.

Introduction

Humans are a highly adaptive species, historically managing to live with their surrounding environments and available tools that they had. Humans have long lived in environments less than ideal: from the coldest regions to the highest mountains to the hot, barren desert. Populations have thrived in the desert regions since the beginning of written history, and until recently these areas remained relatively undisturbed. Modern settlement patterns in desert regions, however, are rapidly destroying the natural desert environment, leading to a host of issues. For this reason, sprawl is an issue that planners should certainly not ignore. By becoming more educated on the forces of sprawl, surely solutions can be created.

This paper will present the settlement patterns of two desert cities: Phoenix, Arizona, and Riyadh, Saudi Arabia. These case studies will make a meaningful contribution to the study of desert city sprawl by comparing two cities, on opposite sides of the world with enormous cultural differences. Both cities have experienced dramatic sprawl in recent years, but in different ways and for different reasons. The first section of this paper will introduce current literature pertaining to sprawl in general. The second and third sections will critically examine the case studies of Phoenix and Riyadh respectively. This will include the cities' backgrounds, factors leading to and continuing

to support sprawl, the resulting consequences, planning policies aimed at limiting sprawl, and any additional relevant information. Finally, the case studies will be analyzed to determine what can be learned.

Background on Sprawl

Sprawl is a complex phenomenon, resulting from many underlying social, economic, and political forces. Western scholars have offered slightly differing definitions of sprawl; however, there is a great deal of agreement as to its problematic nature (Fishman, 1989, Goldsmith, 2000). Kahn (2006, p. 110) describes sprawl as "the migration of homes and jobs to low-density areas", while Burgess (1998, p. 1) defines sprawl as "expanding physical development at decreasing densities in metropolitan regions, where the spatial growth exceeds population growth". In summary, sprawl typically contains the following characteristics: low-density, single-use zoning, repetitive development pattern (primarily residential), strip centers, long miles of roadway due to high vehicle dependency, and development occurring outside of urban areas (Calthorpe, 1989, Torrens, 2006).

Causes of Sprawl

Social Causes

There are many social, or cultural, reasons for the occurrence of sprawl. The simplest of these causes is population growth. Growth can occur from increased births, higher life expectancies, and/or migration from rural regions to urban areas. When the

population of a city increases, growth needed to accommodate the additional population can occur upward or outward. Most often, the result is physical expansion of the city perimeter (Williams, 2000).

Personal or cultural preferences have often served as a major contributor to sprawl. For example, the "American Dream" is to own a big house with a backyard, a car to drive, and an orderly, safe neighborhood to raise children. This lifestyle was particularly promoted following World War II, and became increasingly popular among middle-class citizens (Calthorpe, 1993).

Another social cause of sprawl is commonly known as "white flight". White flight can be described as middle- and upper-class families fleeing the urban areas, which commonly contain large impoverished minority populations. For example, high-income persons fled the inner cities during the industrialization period to avoid living among low-income factory workers. The hostility toward minorities was so strong that the Federal Housing Agency (FHA) eventually prohibited non-whites from buying homes in the suburbs (Williams, 2000).

Growing car-culture dominance has undoubtedly contributed to urban sprawl. Suburbs did exist prior to widespread automobile use; however, automobiles made suburban life much easier and more appealing. Cars made travel between the cities and the suburbs quick and convenient. People could work in the cities if needed, then moving back to the peaceful suburbs to live at the end of the day. "The automobile and the highway when they came were no more than new tools to achieve a suburban vision that had its origins in the streetcar era" (Fishman, 1989, p. 29).

Economic Causes

Economic considerations impact development patterns just as they influence most aspects of modern society. One economic cause of urban sprawl is the shift of modern societies from a manufacturing-based economy to a service-based economy. As industrialization gains momentum, industry demand typically brings large labor masses to the inner cities. However, if that industrial sector begins to decline, as many modern nations have already experienced, there is one less reason to reside in the city centers. Abandoned factories, resulting in fewer jobs within the city, lead to decline of the urban core (Fainstein & Campbell, 2002).

After the urban core loses its population, businesses, and other entities, a "rent gap" results. Basically, the declining urban core creates expensive land prices on the city periphery, where only the middle and upper income classes can afford to live. As the troubled city centers expands, so does the periphery. Similar to the experience of white flight, economic limitations result in inner-city housing continuing to be occupied by impoverished minority populations (Smith, 1986). Additionally, inexpensive land in largely undeveloped areas outside of the city fuels the decision to create settlements outside of the city (Fishman, 1987).

Political Causes

Major public policies have in many instances encouraged urban sprawl. Local governments have often supported developments that would attract the middle and upper classes of society to certain areas in area to increase property tax revenues. Federal Housing Administration (FHA) incentives for mortgage lenders in America, as well as low down payments and a longer repayment period, made a house in the suburbs accessible to more people. Further, the U.S. Veterans Administration's VA Loan

Guarantee Program added to the benefit of veterans by not having to pay down payments. Another example of political fueling of Sprawl in the U.S. was the Federal Highway Act of 1965, which enhanced highways and road construction all across the U.S. The expansion of roadways outward from the urban core for many miles has had a major impact on the great expansion of urban regions (Williams, 2000).

Effects of Sprawl

Positive Effects

Although sprawl has been highly criticized by scholars and environmentalists, there are several positive aspects of sprawl. One positive aspect of sprawl is that it has provided many residents with a better quality of life. The suburbs typically allow access to better schools, safer and more orderly neighborhoods, recreation facilities, and other desired public amenities. Basically, urban sprawl has for many led to fulfillment of "the American dream" (Williams, 2000).

Another positive aspect is that many people have financially benefited from it. Sprawl has had a predominately positive impact on the real-estate market. Those who predicted the trend of spreading development outside the city center have purchased undeveloped land on the edges of metropolitan areas. When the demand for this land was at its highest, those investors received large returns by selling to developers (Williams, 2000).

Negative Effects

Although sprawl has indeed provided convenient living for many individuals, it has negatively impacted the community as a whole. As previously mentioned, urban sprawl has a detrimental impact on city centers. According to Goldsmith (2000), the

continuous “white flight” since World War II and migration to the suburbs has resulted in the manifestation of crime and poverty in the city centers. Smith (1986) describes declining cities at the hands of sprawl as “urban jungles” filled with disease, crime, and chaos. Social segregation has also been a key consequence of sprawl, with both social and socioeconomic divides.

The infrastructure needed to provide for suburban developments is very costly, often placing a burden on local governments. This is because suburban developments tend to be built on undeveloped lands, where basic infrastructure does not exist. Governments must then pay to connect these developments with existing utilities in the cities (Heim, 2001). Furthermore, although channeling basic utilities to new suburban developments costs more than in existing areas, residents of these new developments do not pay more for them (Khan, 2006).

Sprawl is also quite harmful to the environment. On average, people in the suburbs travel by automobile 31 percent more annual miles than urban residents with comparable incomes. By greatly increasing the use of single-occupant vehicles for commute, increased carbon dioxide emissions lead to significantly more air pollution, as well as polluted water streams (Khan, 2006).

Urban sprawl consumes a great deal of land and water. Developers choosing natural lands in order to maximize profit are typically unconcerned with the impact on the ecological system. It has been estimated that a development’s ecological footprint for non-arid regions can exceed its physical area by up to 20 times in some cases. The species whose homes are within these natural lands are continuously driven away into living space that is getting smaller and smaller (Khan, 2006). Additionally, suburban

areas consume more water than urban areas. In fact, it has been noted that 10 percent of water usage could be reduced with an increased density of 4-5 units per acre (Khan, 2006).

Sprawl in Desert Regions

While sprawl has been highlighted as a major issue in non-arid regions, the problem is increased in arid regions, where natural resources are scarce. Deserts experience high daytime temperatures and cooler nighttime temperatures. Surprisingly, desert regions make a meaningful contribution to the ecosystem. They serve as radiators, absorbing heat from the sun during the day and releasing it at night (Schipper, 2008).

Desert sprawl not only affects the land's ability to radiate, but also brings desertification to many regions. Desertification is a dangerous phenomenon caused by the "degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climate variations and human activities (United Nations, 1992). Since desert regions are even more lacking in terms of resources than non-desert areas, desert developments cause further environmental degradation by channeling resources from far away areas. This expands the impacted areas to much further than the settlement's physical location (Travis, 2007).

There have been mature desert cities developed in a manner that works well with the desert environment. Meunier (n.d.) surveyed many long-enduring desert cities in various countries in order to better understand their development patterns. He found that many of these cities share similar characteristics such as providing shades to walkways, using earth materials for building, utilizing natural lighting and ventilation, and adopting a compact urban form. Desert cities built in this manner are far less harmful to the

environment and are much more sustainable over time than those relying on artificial environments.

The understanding of the impact of open space in desert regions is crucial. Open spaces should not be passive but should be planned and treated as active spaces. There is a great deal of importance regarding the size, location, and distribution of these open spaces in order to control the microclimate they can generate. Open spaces should be paved to reduce hot winds and dust movement. They also need to be small in size and they need to be distributed throughout the city. The distribution of open spaces makes them more easily accessible to residents, creates large shadowed areas, and reduces stress on the desert climate (Golany, 1983).

Compactness is a major principle of settlement patterns in most desert cities. Along with serving defense and social unifying purposes, as well as preserving agricultural land, it provides a sustainable settlement pattern in the desert. This form contrasts with the sprawling pattern, which spreads over large areas. To measure the difference between the two opposing patterns, Golany (1983) compared two urban forms on 48 acres with an equal number of housing. In the sprawling pattern, roads consist of about 13 percent of the area, rather than 7.2 percent in the compact form. Infrastructure lines decreased from 27.9 to 7.8 percent, traffic lights from 24 to 6, and fire hydrants from 51 to 25. Golany concludes that the compact form demonstrates a great deal of energy reservation, infrastructure reduction, land saving, and sustainability in the desert.

Fighting Sprawl

In response to the various negative economic, social, and environmental impacts of sprawl, many governments have begun to take steps toward limiting it. It is important

to note that there is no single solution for sprawl. There are only ideas for how sprawl could be limited. Tools that may work for one region may not necessarily be effective in another region. The following are a summary of the major approaches developed to limit the effects of sprawl:

1. Development impact fees: This tool involves requiring developers to pay a portion of the costs typically paid by local governments to connect new suburban developments with existing resources within the cities (water, sewage, electric, etc.). Although these fees are certainly understandable, the downside is that the increased costs are typically just passed down to tenants or homebuyers, making the suburbs less affordable (Kelly, 2004, Heim, 2001).
2. Preservation of rural land: In the United States, 14 states have now established Purchase of Development Rights program (PDR). This program provides full cash payment to farmland owners in order to preserve the use of the land for agricultural purposes. The payment equals the assessed value of the land, and the agricultural use specification is noted in the deed in order to maintain the same use in the future. Another program is the Transfer of Development Rights (TDR). Under this program, the government issues a development credit to farmland owners based on assessed value. Owners then often sell these credits to developers, who in turn use these credits to further develop into designated high-density zones (Williams, 2000).
3. Smart Growth: This program is one of the most well-known sprawl management tools, providing a model of how communities should grow according to previously developed growth plans. The program includes setting growth

boundaries, high-density developments, efficient public transportation systems, and pedestrian-friendly developments (Williams, 2000).

4. Infill development: This approach consists of shifting the development trend from rural regions to underutilized urban areas. This approach traditionally applies to housing developments, but could be applied to businesses as well (Williams, 2000).
5. Design-oriented solutions: "New urbanists" have provided several ideas for how to revive the cities through creating utopian-type developments. These developments would typically include superior transportation systems, mixed-use developments, parks, open space, and the ability to walk to and from these surrounding facilities (Calthorpe, 1989).

The Case Study of Phoenix

Phoenix is the capital of Arizona and the major city in Maricopa County. It is considered the fifth most populated city in the US with a population of 1,567,924 in 2008 (City-data, 2008). Maricopa county hosts 18 cities and is ranked the forth most populated metropolitan area. According to the U.S. Census Bureau, the county had a population of 4,023,132 in 2009, hosting the vast majority of Arizona's total population of 6,595,778. Phoenix is also the center of the larger Phoenix metropolitan area, which consists of Maricopa and Pinal counties, hosting 24 cities and towns. The Phoenix metropolitan area is considered one of the fastest growing metropolitan areas in the US. In fact, between 1990 and 2000 its grew by 45.3 percent. This figure is about three times the national growth rate (US. Bureau of Census, 2000).

Growth From 1870-1970

Salt River Valley is the extensive valley on the Salt River in central Arizona that today contains the vast metropolitan area of Phoenix. It was originally barren desert, largely uninhabited and somewhat undesirable. However, railroads were brought to the area in the 1880s, leading promoting increased development. Later, in 1927, air service to Phoenix would begin, making the area even more accessible (Rex, 2000).

In the early 1900s, following the completion of the Roosevelt Dam, irrigation possibilities allowed the land to be increasingly developed for agricultural purposes. The use of the Salt River Valley for ranching and irrigated farming grew considerably through the 1940s. The area eventually became known for cattle, cotton, and citrus (Rix, 2000). Tourism also began in the early 1900s, but was then limited to the wealthy and to health seekers wishing to reap the benefits of the area's warm, dry air. Up to the 1940s, most residents of Maricopa County lived in unincorporated areas with weak local government. However, the area began to experience substantial growth in the early 1900s as a result of very few restrictions placed on the private sector and the use of land. In fact, Phoenix more than tripled in population between 1900 and 1940, from 20,000 to 65,000 (Rex, 2000).

During World War II, the federal government saw that Phoenix was a strategic location to connect the east and west regions of the nation. Two air force bases and a military training facility were opened, introducing many servicemen to the area (Rex, 2000). Over the years, many ex-soldiers decided to settle in Phoenix because of its nature and affordability (Simon, n.d.). The growing use of air conditioning eliminated the concern of exceedingly high summer temperatures. Also, the growing use of automobiles brought more people to the area and allowed them to move around the region freely (Heim, 2001).

Soon, the Phoenix area began to attract both retirees and families. The local government supported this growth because it would increase tax revenues. In the early 1950s, Phoenix began to transition from an agriculturally based community to one known for manufacturing, particularly in electronics (Simon, n.d.). Key contributors to this

transition included the creation of a Motorola site in Phoenix and the Army's decision to designate the city as the proving ground electronic defense equipment. Other manufacturers also brought employment and growth opportunities to the area (Rex, 2000).

The population of Phoenix more than quadrupled between 1950 and 1960, from about 106,800 to 439,170, and then reached 579,170 by 1970. This extraordinary growth from the 1950s began the process of excessive urban sprawl and the common practice of leapfrogging, which occurs when developers skip over properties to obtain land further out, leaving vacant tracts behind. This rapid growth was nearly impossible to control due to strong commitment to growth, competition with other local regions, and "frontier values" of high levels of freedom and low levels of government control (Heim, 2001).

Growth From 1970-Today

Although sporadic development was already occurring, a new period of rapid residential growth began to expand out into what had previously been relatively remote parts of the valley around 1970. Planned communities began spreading outside of Phoenix from all four directions (Heim, 2001). This growth was fueled by the newly mature economy and the baby-boom generation entering their 20s (Rex, 2000). By 1972, the Greater Phoenix area had sixteen major planned communities ranging from 640 acres to over 10,000 acres in size. These planned communities were examples of both leapfrog development and strip, or ribbon development along major transportation routes and continuous low-density development (Heim, 2001).

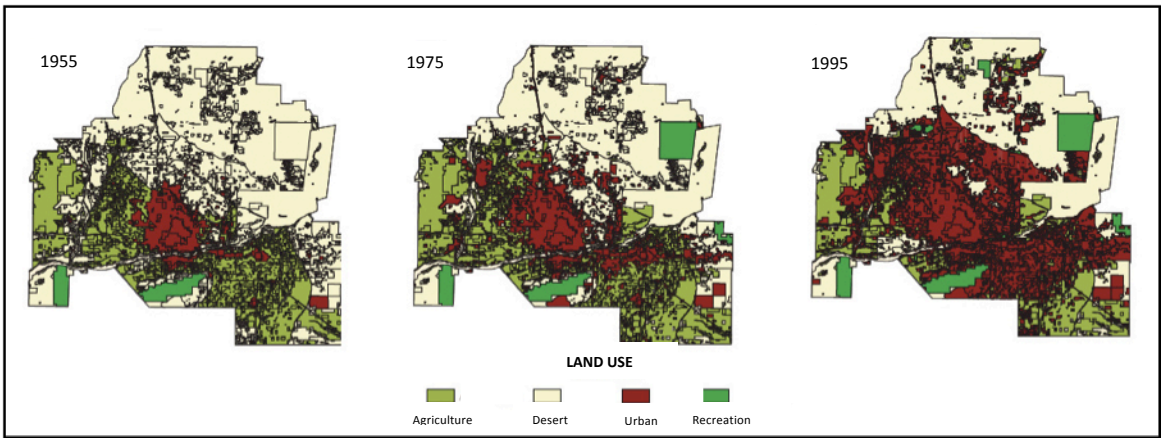

Figure 1: Growth in Phoenix metropolitan area between 1955 and 1995. Adapted from Morrison Institute for Public Policy. "Metropolitan Phoenix land use change from 1955 to 1995" [Map]. In: Hits and misses: Fast growth in metropolitan Phoenix, 2000, p.19. Retrieved March 27, 2010 from Solimar research group website http://www.solimar.org/pdf/hitsand

This rapid population growth has caused a huge demand for housing. Investors bought huge tracts of inexpensive agricultural lands and converted them into housing lots ("Phoenix: The Urban Desert", 2003). The Phoenix metropolitan region grew faster than any other metropolitan region between 1970 and 1998. From just 1990 to 1998, the region's population grew 31 percent (see Figures 1 and 2). During this period, 8 of the 24 cities in the Phoenix metropolitan area actually experienced a population increase of more than 50 percent (Morrison Institute for Public Policy, 2000). There was originally concern over whether these communities could be self-contained as genuine towns, or would necessitate long journeys to work (Heim, 2001). Soon, the sprawling Phoenix area would begin to be seen as a major issue, which continues to be dealt with today.

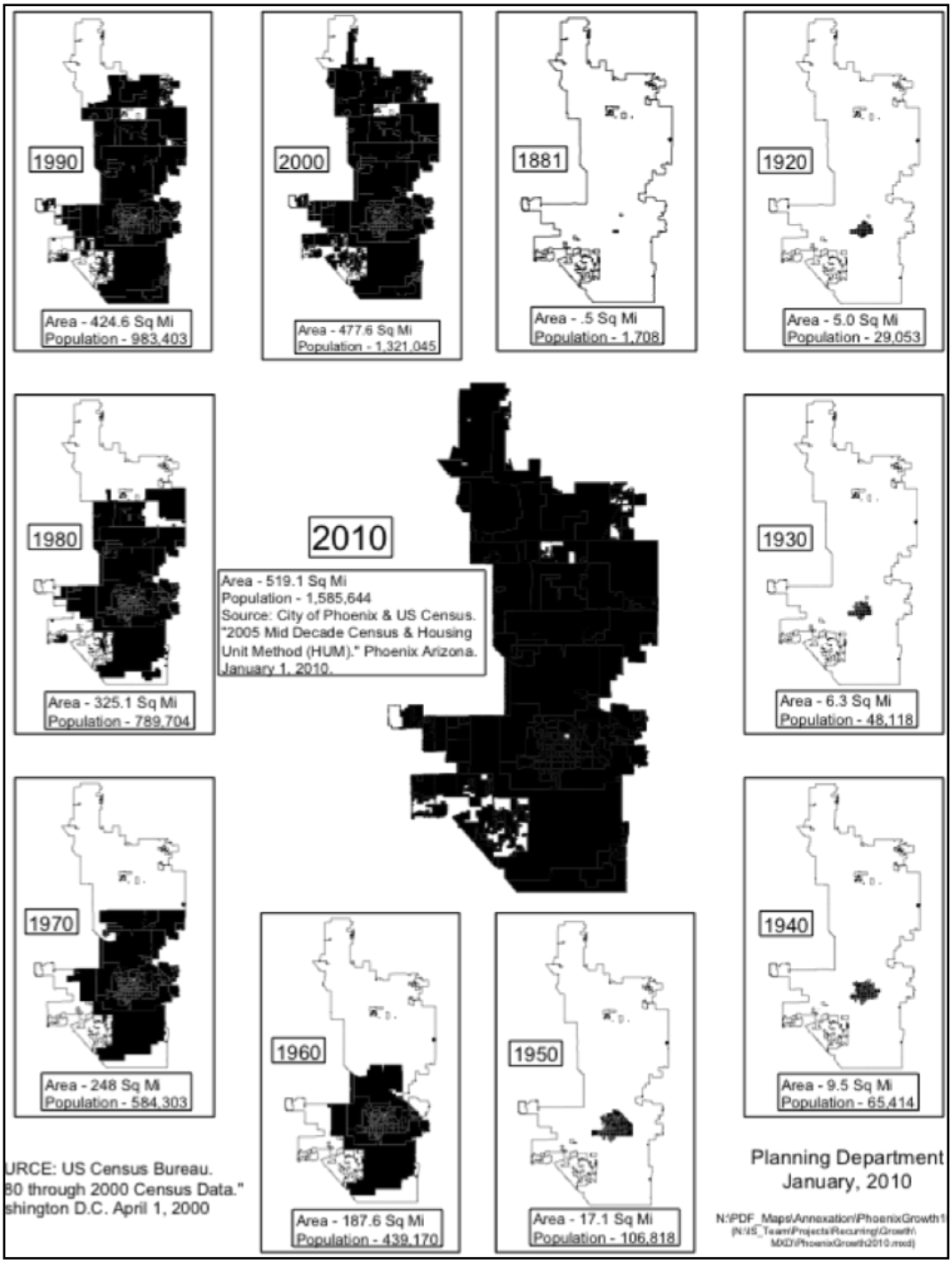

Figure 2: Growth in Phoenix over the years. Adapted from The City of Phoenix. "Growth in Phoenix" [Map]. Retrieved March 27, 2010 from the city of Phoenix official website http://phoenix.gov/planning/phoenix

Sprawl in Phoenix

High Automobile Dependency

While rapid growth has increased the "creative class" in the Phoenix area and widely expanded local markets, it has also challenged the region's infrastructure and natural resources, particularly in the areas of the metropolitan periphery. There were many negative results. One of these is of enormous traffic congestion with longer commutes and significant air pollution (Morrison Institute for Public Policy, 2000). Basically, development patterns in Phoenix have long led to increased automobile use, which harms the environment and crowds roadways. Additional roadway construction aimed at reducing traffic congestion has actually led to even more traffic. When roads are built, people will use them. The resulting consequence is a smoggy cloud locally known around Phoenix as the "brown cloud" (Pasqualetti, n.d.).

Low-density developments and high car dependency raises many air quality concerns, such as the brown cloud, urban heat island, and green house gases. According to the World Energy Source (2008), every car produces 19.4 pounds of carbon dioxide for every gallon of gasoline (World Energy Source, 2008). In Phoenix alone, it is estimated that the amount of carbon dioxide emitted equals 8,360 pounds annually (Kenworthy, 2003). Low density contributes to poor air quality resulting from automobile use as well. The lower the density, the more cars are being used. Consequently, more paved roads are required, absorbing more heat (Pasqualetti, n.d.).

Excessive Annexation

One major characteristic of Phoenix is that of endless annexation. The annexation process has been justified as a tool to control and protect unincorporated land from

developers who target these areas. However, this process appears to have contributed to sprawl by absorbing suburbs and increasing the city's population. During the 1980s, the observed trend seen was one of that spurting outward. This shift was the result of an aggressive competitive nature; especially evident in the eighteen less populated cities. These cities competed to add new developments within their jurisdictions, which contributed in the expansion of these cities' total areas. The eighteen less populated cities host 11 percent of the metropolitan area's population. However, they control more land than the city of Phoenix and the five largest suburbs combined. In 1998, these small cities covered 667 square miles compared to 470 square miles in Phoenix, and 449 square miles of the five largest suburbs. Furthermore, between 1970 and 1990, the distance between the fringe and downtown Phoenix doubled from 10 to 20 miles. This distance continues to increase (Morrison Institute of Public Policy, 2000).

Socio-economic Factors

The growth demand of this region was concentrated on housing located outside of the urban center. As previously noted, this is problematic when governments are faced with the task of supplying basic infrastructure and resources to these new settlements (Schipper, 2008). Subsidized water and electric for these extended communities was originally a burdensome expense for Phoenix. Additionally, those "communities that are relatively small and inexperienced, or where growth outpaces the rate at which tax rolls and census counts can be updated to ensure various revenue flows, have been hit hard by sprawl in the Phoenix area."(Morrison Institute for Public Policy, 2000, p.8). There is now significant potential for regional issues. These small communities are lacking in terms of growth management control in comparison to neighboring larger cities. As a

result, their municipalities' decisions to control this rapid growth can impact the entire region (Morrison Institute of Public Policy, 2000).

In the case of Phoenix, the urban core is not "hollowing out". Instead, the area has simply segregated along lines of race and socioeconomic status. The region's poor and minority residents have become very segregated in what is now the core of Phoenix. Unlike what is commonly the case with urban sprawl, families with resources have moved away to the fringes, while a great number of jobs and business maintained in the core. In fact, 32 percent of the total employment is located in the metropolitan core (Morrison Institute of Public Policy, 2000). However, the remaining urban center is characterized by crime, poverty, and chaos, with a substantial homeless population (Rex, 2000).

Socio-economic segregation can be clearly observed in the city. There is a concentration of whites in the north, south, and northeast part of the city, and minorities, a great proportion of which are poor, are largely located in the central and southwest areas (see Figure 3). This spatial segregation of income levels and ethnicities has affected the housing market. As of 1996, most development projects were located up to 15 miles north and northeast from Phoenix's downtown, in less diverse communities. These developments are leaving behind the less fortunate minorities (Morrison Institute of Public Policy, 2000). As shown in Table 1, the concentration of minorities, particularly Hispanics, in a central area with 49.9 percent of residents having an income below poverty level. In the northeast and the far south, mostly populated by whites, 3.1 and 1.4 percent of its residents' income falls under the poverty level, respectively.

Table 1:

The city of Phoenix demographics in different zip codes in 2008

Demographics Criteria	Northeast (85050)	Southwest (85043)	South (85045)	Central (85009)	Arizona
Average household size	2.6	3.5	3	3.8	2.6
Median household income (Dollars)	79,056	38,981	127,872	31,103	50,958
Residents with income below the poverty level (Percent)	3.1	25.6	1.4	40.9	14.7

Source: City-data, 2008

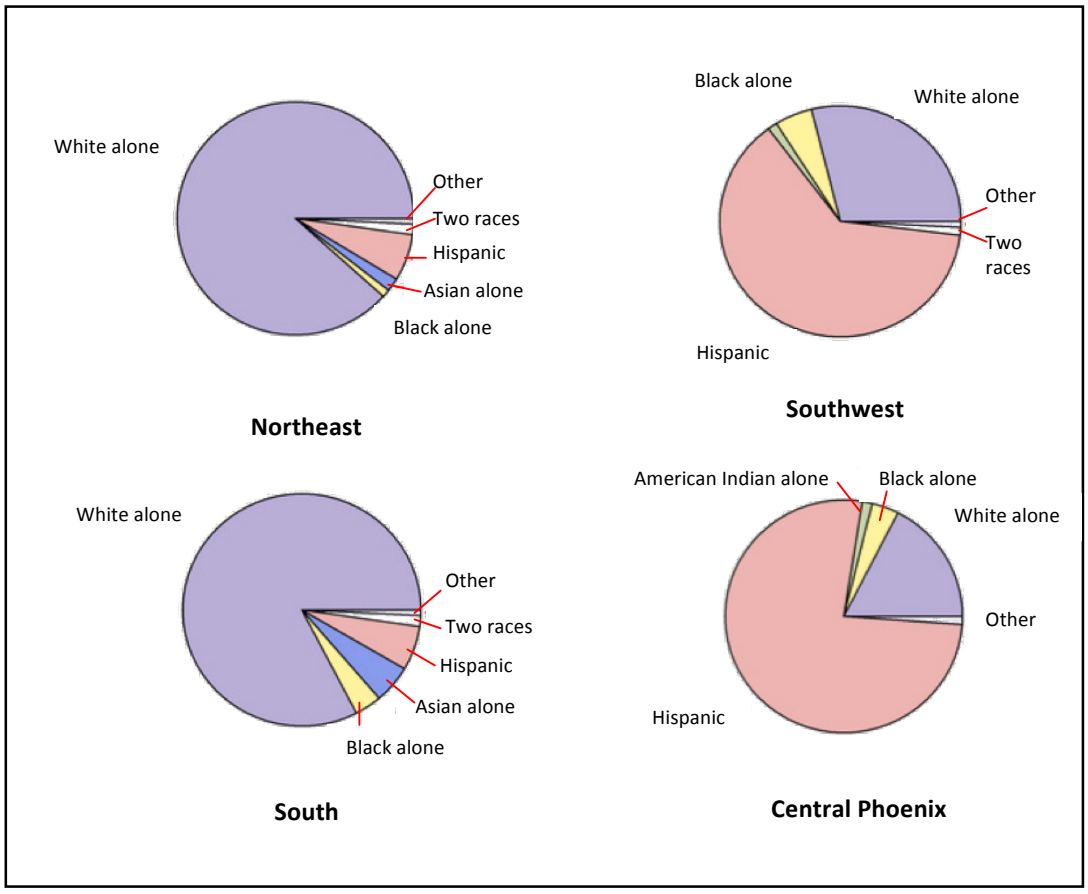

Figure 3: Social segregation in different parts of the city of Phoenix. Collected from City-data. "Ethnicity by zip code" [Chart]. Collected May 25, 2010 from http://www.city-data.com/city/Phoenix-Arizona.html

Contrary to the sprawling pattern, the density of Phoenix is increasing. Increasing density, however, is not an achievement by itself. For example, between 1990 and 1995 central Phoenix's increase in density was a result of more inmates in prisons and homeless in shelters (Rex, 2000). Another reason for the increase in density, although housing vacancy is increasing, is the increase in household size, especially in central and southwest areas reside by Hispanic populations (Morrison Institute of Public Policy, 2000).

Planning Policies

In the 1960s, the Phoenix metropolitan region settlement of Scottsdale made attempts to increase density by creating a general master plan. The plan was to develop amenities in addition to housing developments outside of the cities, which was in contrast to subdivisions which consist of housing units developed in the hope that amenities such as shopping, commercial centers, schools, and parks will develop around them. However, since these developments were primarily located outside city limits, this continued to destroy the desert and done nothing to alleviate the need for long commutes (Schipper, 2008).

Another attempt was the Indian community in Cave Creek. The community tried to reduce environmental impact through another master planned development. They advocated environmental preservation and developed the *rurban development*, or urban-scale development in rural areas. The plan consisted of preserving nature, building with local materials that blend with nature, preserving energy, and maintaining a very low-density development of one unit per 7.5 acres. However, the problem with this approach

was that it still encouraged development in the desert. In fact, during the period of 1990-2000, the community grew by 27 percent (Schipper, 2008), significantly more than the Phoenix growth rate of 2.5 percent (City of Phoenix, 2002). Instead of reducing the negative impacts of sprawl, Scottsdale and Cave Creek both compounded the issue.

After extensive leapfrogging as the result of master planned communities, such as those mentioned above, the Arizona Groundwater Management Act of 1980 was the first attempt to limit leapfrogging development. This act required developers to provide proof of a 100-year water supply to their development project other than groundwater in order to qualify for development approval. Along with this act, the comprehensive plan began requiring that new developments be located within one mile of an existing development. These policies were viewed as highly effective in preventing developers from destroying the natural environment and pushing the fringe of the city further away (Heim, 2001).

To limit the utility expenditure on faraway developments, the city of Phoenix eventually imposed a development impact fee policy, as well as an infill-housing program. In order to detract the single-family housing trend, Phoenix began to impose single-family impact fees ranging from $2,000 to $9,000 per home, depending on the home's location. These impact fees, although perhaps limiting the suburban growth pattern, have been criticized for having a negative impact on affordable housing. The impact fees do not impact developers alone, but also the residents and homebuyers as well. In order to offset these fees, developers typically pass them down to homebuyers, thus raising home prices. Another negative impact of impact fees is that it fuels leapfrogging, as developers simply move further away from the current local government

jurisdiction (Heim, 2001). Thus, these fees also cannot be seen as the ultimate solution to sprawl.

The current General Plan for Phoenix contains plans for dealing with current planning issues the city faces. The plan is based upon an urban village concept adopted in 1985 following vast horizontal expansion of the urban region. The 14 urban villages (see Figure 4), each has a center, gradient, and fringe, are meant to create independent communities contained within the major city (Heim, 2001). Urban villages are designed to contain an assortment of housing options, employment opportunities, shops, recreational amenities, and educational facilities (City of Phoenix 2002).

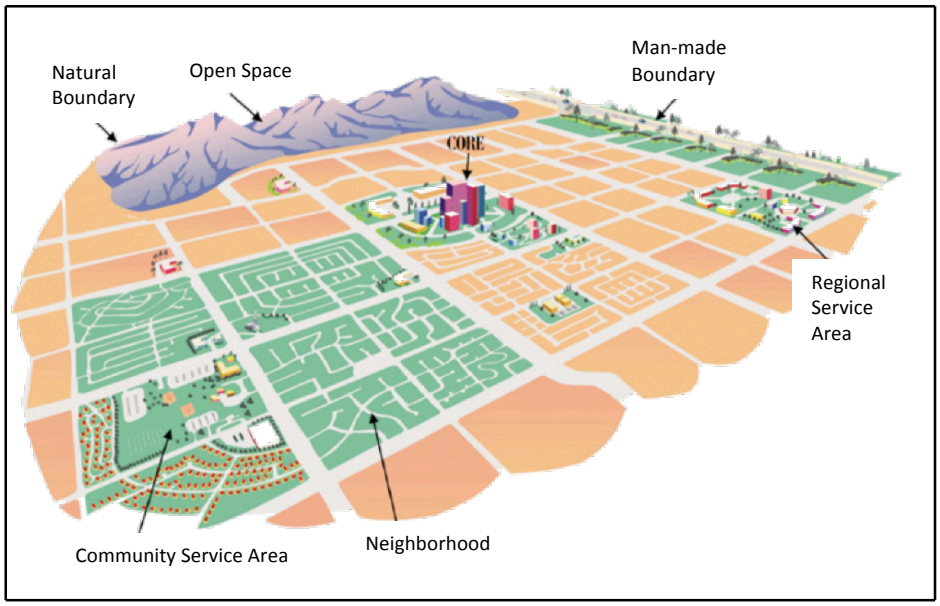

Figure 4: The Urban Village concept. Adapted from City of Phoenix. "Phoenix urban village model" [Diagram]. Phoenix general plan: Land use, 2002, p.48. Retrieved Feb 10, 2010, from: http://phoenix.gov/PLANNING/gpland1.pdf

The preservation of natural open space is another component of these villages. They are meant to be recognizable communities within the city. The individual villages

and their peripheral regions were defined, including a substantial portion of land outside city limits to allow for expansion. Updates for the General Plan continue to emphasize environmental protection, as well as highlight necessary efforts to retain the unique identities of the villages, including the protection of historic and cultural landmarks (City of Phoenix, 2002).

Pedestrians should be able to easily access basic neighborhood amenities. Regional amenities, which may attract outside visitors (stadiums, universities, hospitals, etc.), might require automobiles or other forms of transportation. Each village can accommodate a future population of 75,000 to 200,000. These villages offer a balance between housing and employment, and involve the public in planning decisions through each village's planning committee (City of Phoenix, 2002). It is also believed that these villages are capable of regaining a lost sense of community and identity at the hands of suburbanization.

General Plan also limits growth by identifying six planned growth areas within the Phoenix city boundaries (see Figure 5). One of these growth areas is the Infill Incentive District, located in the city's urban core. Within this district, incentives are offered for housing and community service developments on vacant and underutilized lots. Developments taking place in the other five growth areas are charged development impact fees and utility charges (City of Phoenix, 2002).

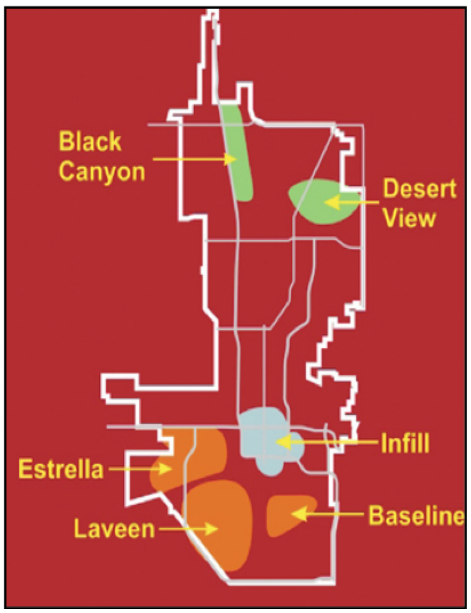

Figure 5: Targeted urban growth areas in the city of Phoenix. Adapted from City of Phoenix. "Targeted growth areas" [Diagram]. Phoenix general plan: Growth, 2002, p.19. Retrieved Feb 10, 2010, from: http://phoenix.gov/PLANNING/gpland1.pdf

The expansion of all growth areas, excluding the Infill Incentive District, is suggested within the Cost of Development plan element. The Housing element advocates providing various housing types, capable of serving a wide spectrum of social groups, in order to address the sprawl-related issues of few affordable housing options and lack of housing diversity. In response to excessive water consumption resulting from the desert city's enormous sprawl, the Water Consumption element emphasizes the importance of reasonable consumption levels and providing water to the city during both normal and dry periods. It identifies available water resources that could be used sensibly while yielding a safe level of ground water through artificial refill. Additionally, this element emphasizes using reclaimed water for irrigation and industrial uses, and maintaining a Water Resources Acquisition Fee to provide water for new developments (City of Phoenix, 2002).

The Water Acquisition Fee was established in 1990. It is updated annually in connection with the city's water resources plan. Phoenix has been highly successful in reducing water usage per capita in recent years. In 1980, the city water consumption was 260 gallons per capita per day. As of 2000, this figure was reduced to 224 gallons per capita each day, with a reduction of about five percent annually (City of Phoenix, 2002).

As mentioned above, environmental conservation is now a key feature of the city's plan. The plan promotes natural land preservation, the establishment of community gardens, and the improvement of air quality. In 1998, the city council approved the Sonora Desert plan in order to add an additional 25,000 acres to the existing 27,000 acres. To accomplish this, the city approved a one-tenth of a cent sales tax for ten years in order to raise funds to acquire such lands. Community gardens aids in land preservation, and also provides fresh produce for the community (City of Phoenix, 2002).

The plan's specifications for air quality improvement have led to the development of a light rail system in 2008 and significant improvements to the existing bus system. The purpose of these changes was to serve all urban village cores while reducing car dependency, thereby reducing the number of vehicles emitting carbon monoxide into the environment. The city has also supported converting cars from gasoline usage to using compressed natural gas, a cleaner alternative (City of Phoenix, 2002).

The Case Study of Riyadh

Riyadh is the capital city of the Kingdom of Saudi Arabia. It is a very rapidly growing city with one of the lowest densities in the region, located on the Najd Plateau in the nation's central region. Although modern Riyadh was created less than a century ago, it now contains 25 percent of the total Saudi population. Due to various factors, the city has expanded greatly. Urban sprawl, although not fully realized, is a major issue for the Riyadh region (Arriyadh Development Authority [ADA], 2005).

History from 1900-1950

Urbanization began in Saudi Arabia soon after King Abdulaziz founded the Kingdom in 1902. Soon after, the king announced a vision of shifting the nomadic lifestyle of the Bedouins (consisting of 60 percent of the total population), moving them to small state-established settlements *(Hijjar)*. The urbanization of Bedouins carried underlying economic, political, and social benefits. During the early stages of the settlement of Bedouins, the breaking down of mobility barriers was clearly observed, and the people began to seek better opportunities in urban areas (Marabak, n.d.).

At that time, old Riyadh was a small walled town with a unique, compact urban fabric (see Figure 6). It consisted of a mosque, market, and the King's palace, surrounded by houses. Houses had no openings to the outside, instead consisting of an

inward opening to the courtyard, due to the importance of privacy in Islamic culture. Furthermore, the traditional home demonstrated adaptability to the desert environment by providing shadows during the daytime, preventing inner spaces from receiving direct sunlight (Mubarak, n.d.).

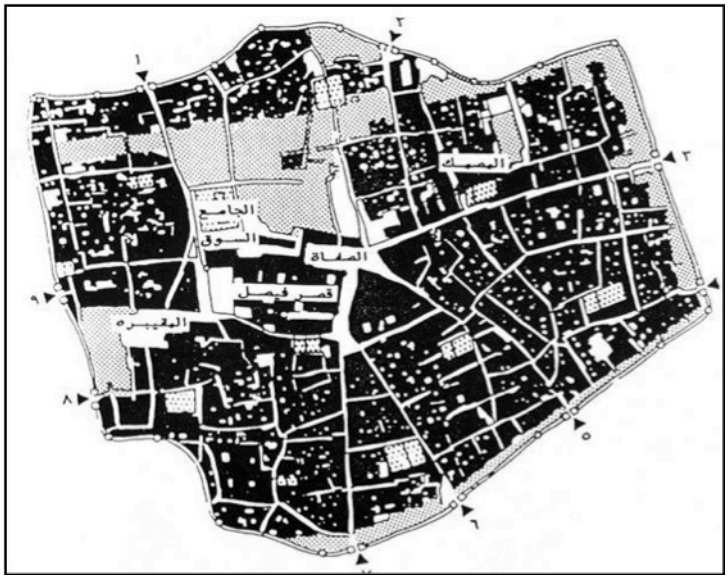

Figure 6: Old Riyadh was a walled town. Adapted from Mubarak, F. "Riyadh still a walled town in 1950" [Map]. In: Al-Hathloul, S. & Edadan, N. (Ed.), Urban development in Saudi Arabia: Challenges and opportunities. Riyadh: Dar Al Sahan, n.d., p. 256.

During this period, there were around 400 *Hijjars* on Najd plateau, which encompasses the greater Riyadh region and the surrounding areas. These *Hijjars* consisted of 298 small settlements of less than 250 inhabitants, 77 medium settlements of between 251 and 700 inhabitants, and 25 larger settlements of over 700 inhabitants. It is known that residents from further away *Hijjars* began to migrate to the urban areas of the Najd plateau, although the details of this migration are unknown due to a lack of reliable data. With the discovery of oil in the 1930s, urbanization increased even more (ADA, 2005).

History from 1950-1970

A great deal of growth occurred in the Riyadh region during the 20-year span of 1950-1970. The Riyadh area was experiencing a great deal of peace and stability as a result of increasing wealth from oil production. Migration from rural to urban areas increased dramatically, horizontally expanding the city (Al-Khalifah, n.d.). Riyadh's walls were demolished and modern facilities were built, complete with utilities such as running water, electricity, and telecommunication capabilities. In 1951, major highways were constructed connecting Riyadh to the eastern and western regions. This was followed by the construction of King Khalid airport, located 35 kilometers north of the city (Alskait, 1993).

Due to the strategic location of Riyadh in the nation's center, the decision was made in 1954 to relocate all government ministries to the area. As a result, a new housing pattern in the city emerged. When the ministries moved to Riyadh's *Almalaz* neighborhood, they brought with them a new settlement style consisting of a grid subdivision pattern (see Figure 7). Governmental officials' housing complexes consisted of villas and apartments. This concept was different than the traditional Saudi design in that it consisted of lower-density development, required more space to accommodate automobiles, and opened outward toward the street, violating the predominate culture of emphasis on privacy. After the Deputy Ministry of Interior for Municipalities applied this pattern all across the country, this became an accepted living style for city residents (Mubarak, n.d.).

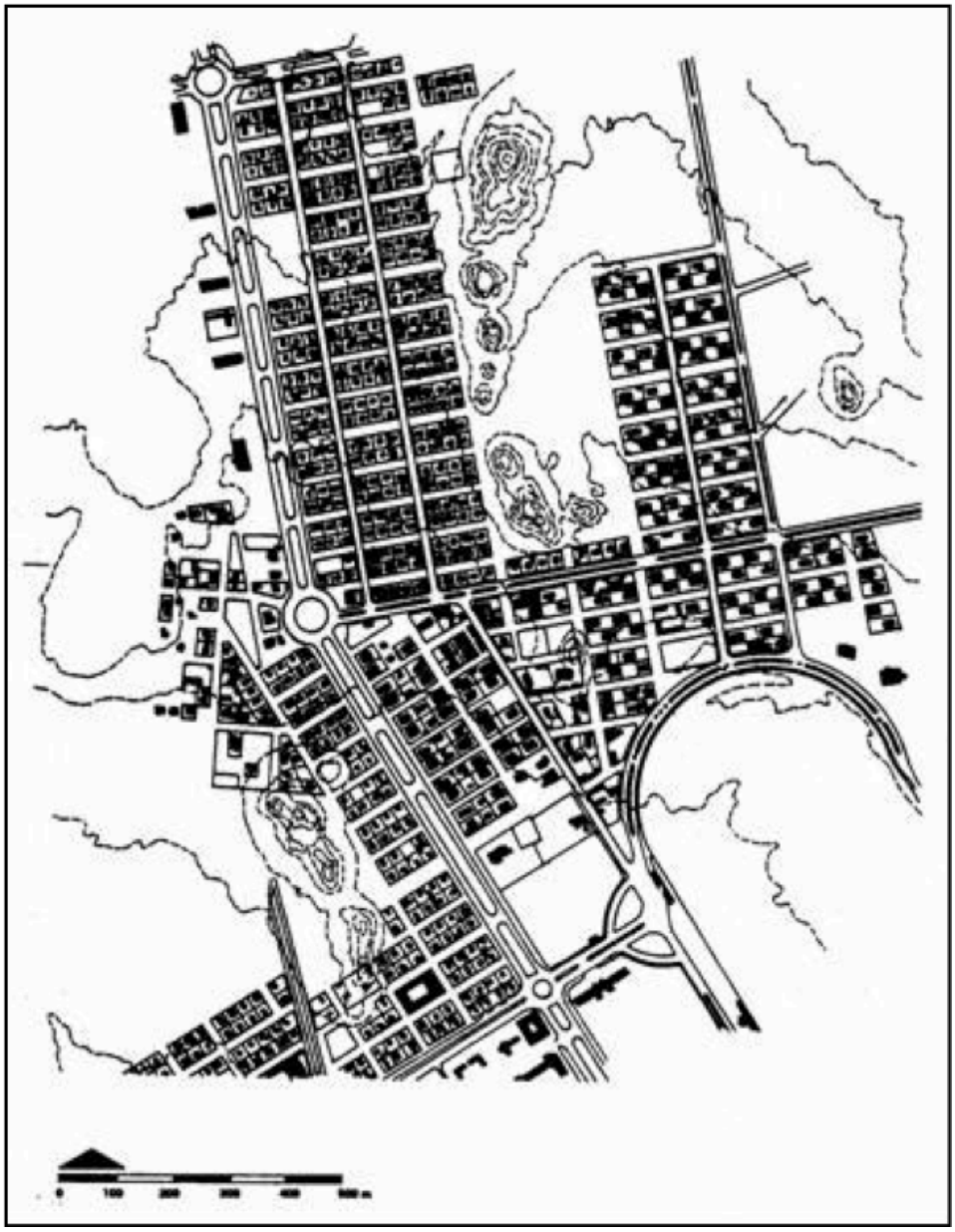

Figure 7: Almalaz Neighborhood, which is considered the turning point for urban form. Adapted from Mubarak, F. "Al-Malaz was built to house the government's civil employees in Riyadh" [Map]. In: Al-Hathloul, S. & Edadan, N. (Ed.), Urban development in Saudi Arabia: Challenges and opportunities. Riyadh: Dar Al Sahan, n.d., p. 264.

The establishment of *Almalaz* neighborhood in the north was followed by the establishments of *Al-Badiah* and *Al-Shumaysi* in the west, *Al-Nasiryayah* neighborhood in the northwest, and *Manfuhah* towards the south (see Figure 8). These separate neighborhoods were widely separated and connected by highways. They represented the city nodes for development, leading to leapfrogging in the areas in-between (Al-Fouzan, 1995). It appears that expanding in the desert was overwhelming for developers. Developments had gone beyond the old city in an unplanned manner. Al-Khalifah (n.d.) found that rural-to-urban migration dropped in the 1970s simply because rural areas surrounding the city were absorbed within it.

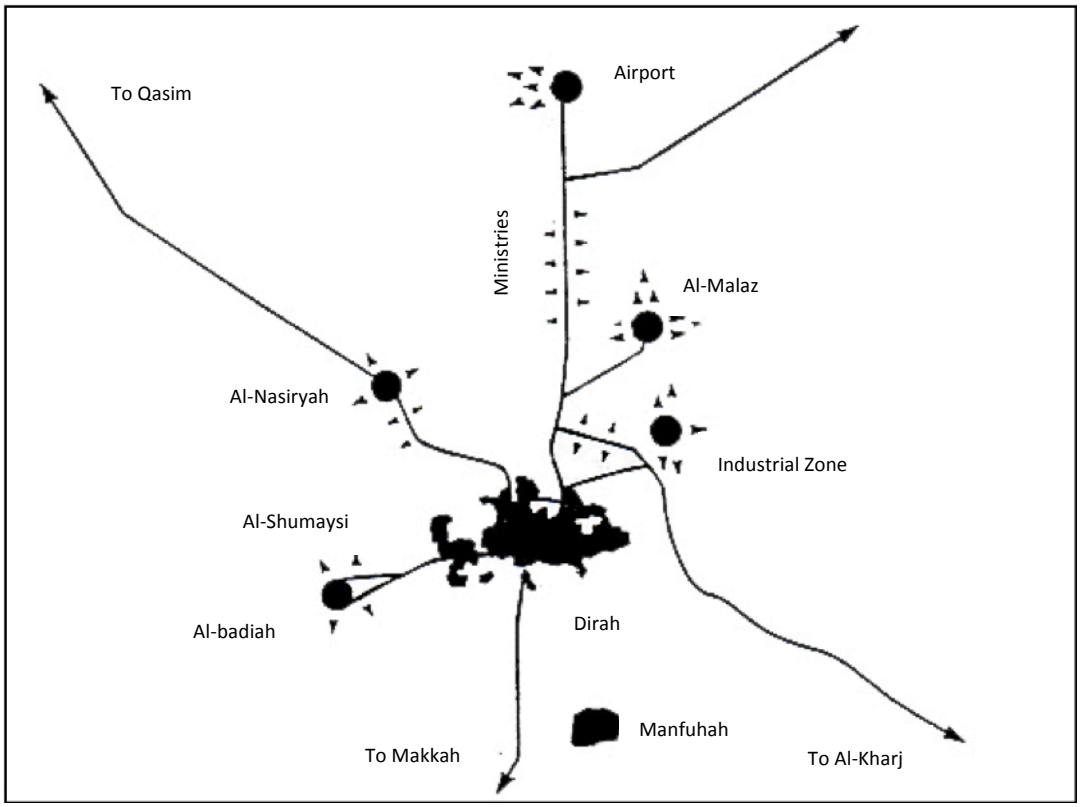

Figure 8: Riyadh's urban growth nodes in the 1950s. Adapted from Wiiliam, F. "Ar-Riyadh nodes of growth in 1950s" [Map]. In: Riyadh the old city: From its origins until the 1950s. IMMEL Publishing, London, 1992, p.322.

History 1971-Present

The Riyadh region's growth increased the urgency for a legitimate city plan to control and guide growth. Due to the lack of planning expertise among the Saudi population, the government consulted foreign planning firms for assistance. The Greek firm Doxiadis Associates prepared Riyadh's first plan in 1971. As shown in Figure 9, the plan aimed to channel growth into a north-south axis, where it would be parallel to the *Hanifa* valley in the west and the escarpment to the east. This plan brought the concept of growth boundaries to Saudi Arabia for the first time. However, the plan's enormous modular grid of 2 kilometers by 2 kilometers encouraged sprawl. By the 1970s, developments had already exceeded the plan's boundaries, requiring the development of a second plan (ADA, 2005).

SCET International of France prepared the second Riyadh plan, implemented in 1982. It introduced the first detailed land-use and zoning systems for the first time. In order to contain sprawl, the plan set a new growth boundary for the city, exceeding the first one (see Figure 10). Also, sprawl began to be seen as a planning issue worthy of thought and planning. This plan was later replaced with another plan in 1996 as the result of continued growth (ADA, 2005).

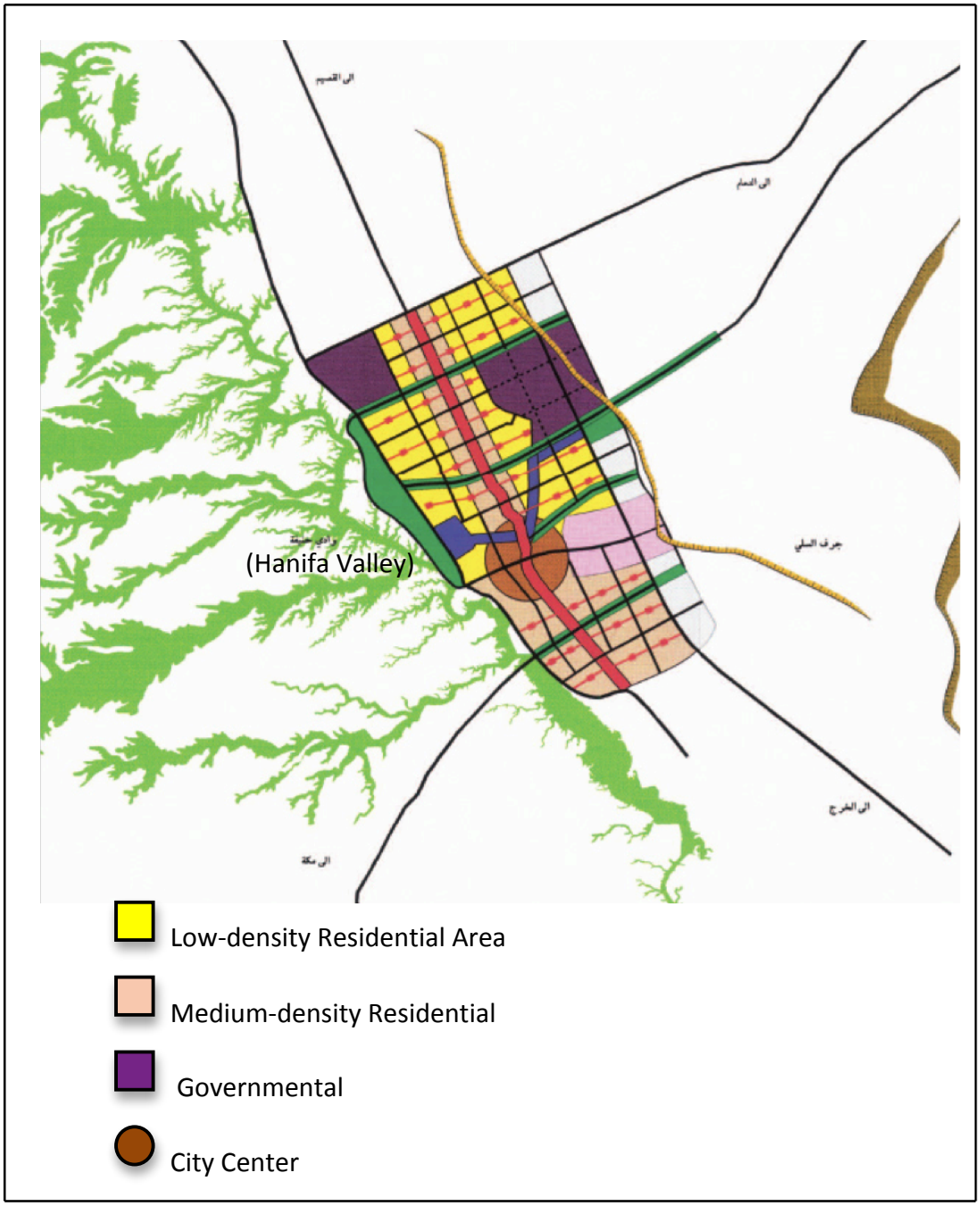

Figure 9: The first plan for Riyadh prepared by Doxiadis Associates in 1971. Adapted from Arriyadh Development Authority. "The first general plan (Doxiadis plan-1393H)" [Map]. In: Total strategic plan for Riyadh city: Land use (in Arabic), 2004, Figure: 2-2. Retrieved Feb 10, 2010, from: http://www.arriyadh.com/ar/cgi-bin/booklet/?get=/MokhatatIstiamalaatAlAradi

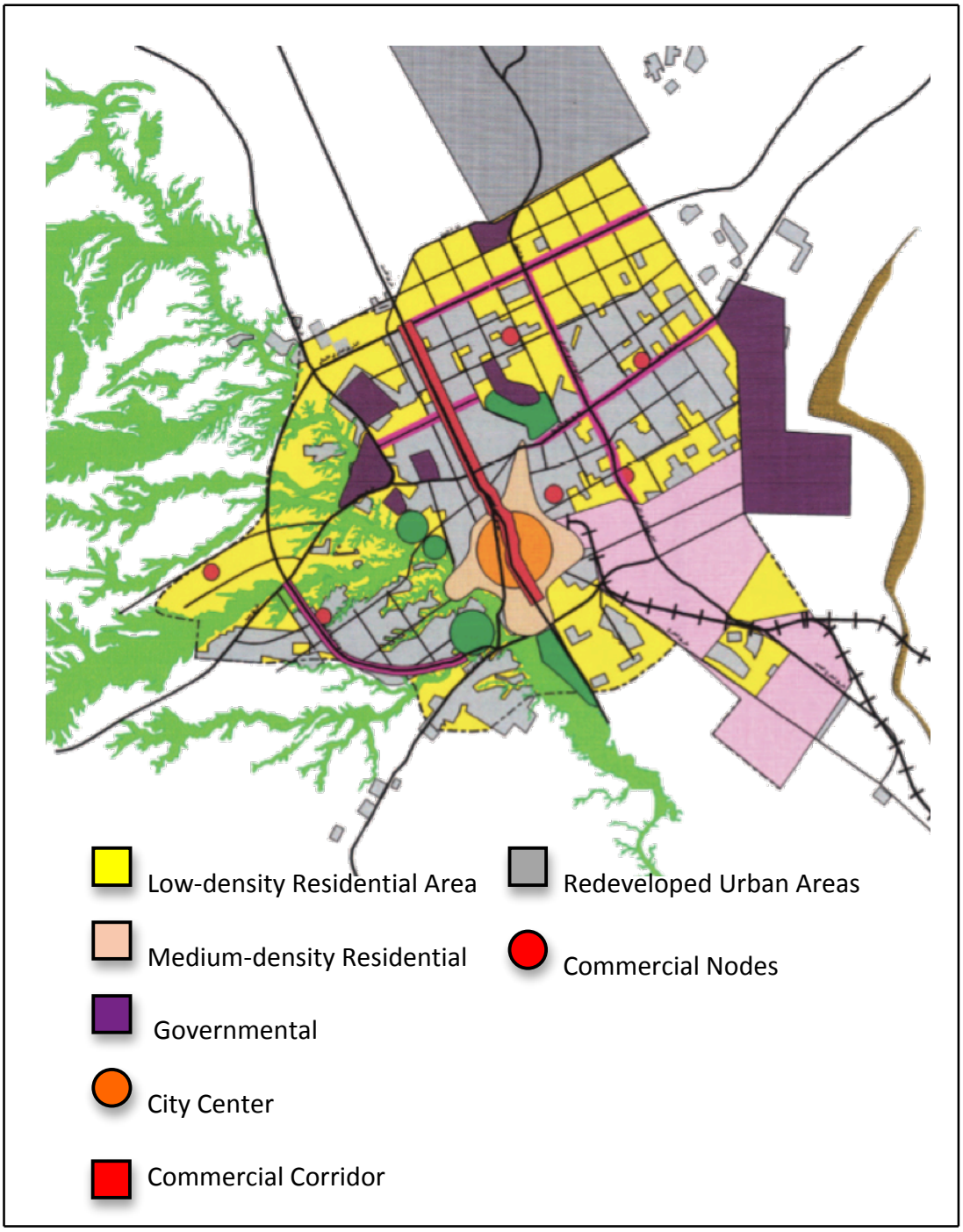

Figure 10: The second plan for Riyadh prepared by SECT Intl. in 1982. Adapted from Arriyadh Development Authority. "The second general plan (SCET Intl. plan-1401H)" [Map]. In: Total strategic plan for Riyadh city: Land use (in Arabic), 2004, Figure: 2-3. Retrieved Feb 10, 2010, from: http://www.arriyadh.com/ar/cgi-bin/booklet/?get=/MokhatatIstiamalaatAlAradi

Throughout the 1970s, oil revenues continued to allow for ever-increasing establishment of physical and institutional developments, most of which were created in Riyadh. Jobs and people came to Riyadh, more than doubling the population from 300,000 in 1968 to 662,000 in 1974. By 1987, this population was around 1.4 million. Within only four short years, this figure grew to an astonishing 2.1 million. Due to the lack of inexperienced labor in the region, a significant portion of migrants came from foreign nations to help build the new infrastructure. At one point in the late 1970s, foreigners' population was 564,400, which represented 42percent of the total population (Telmisani, n.d.). The physical area encompassed by Riyadh tripled between 1960 and 1977 to reach 1,300 square kilometers, then increased tenfold between 1977 and 1983 alone (See Figure 11) (Al-Fouzan, 1995).

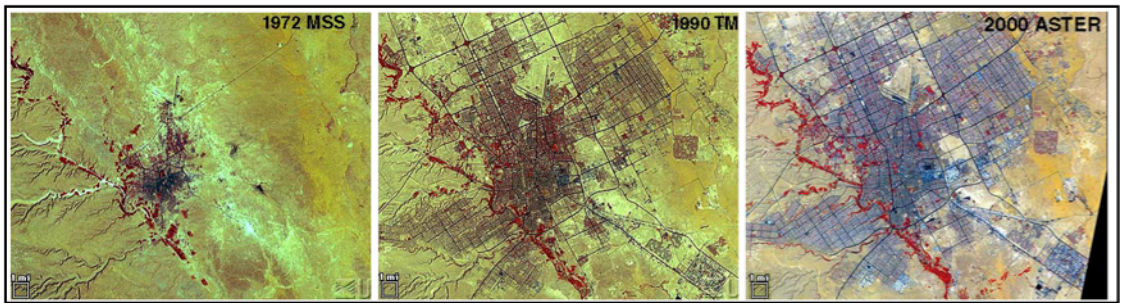

Figure 11: Arial photos for urban growth in Riyadh between 1972 and 2000. Adapted from NASA. "Population growth in Riyadh between 1972 and 2000" [aerial photographs]. Retreived from: http://www.nasa.gov/centers/goddard/news/topstory/2006/arid_phoenix.html

According to the latest data, developments continue to increase in Riyadh, particularly on the periphery regions. The current growth rate in Riyadh is eight percent annually, with a projected 2022 population of 10.5 million. Between 2005 and 2010, developed peripheral areas increased by 29.8 percent. The majority of this development took place on the north and northwest sides of the city. Undeveloped "white lands"

within the growth boundary of 2030 comprise approximately 50 percent of the total land area (see Table 2) (ADA, 2010).

Table 2:

Riyadh's urban indicators

Population	4,878,732
Population Growth Rate (percent)	4
Non-Saudi Population (percent)	32
Average Household size	6.3
Urban Area of Riyadh	2435 square kilometers (940 square miles)
Developed Land	1219 square kilometers (470 square miles)

Source: ADA, 2010

Sprawl in Riyadh

Land Grant Practice

The government of Saudi Arabia commonly grants its citizens free plots of land to construct their homes on. Unfortunately, this practice has the tendency to enhance sprawl. Each Saudi citizen is eligible to apply for this single plot of land if the following criteria are met: over the age of 18, has not been previously granted land, can prove residence in the region in which the application is filed, and does not currently own property (Alskait, 1993). Most often, this granted land is located on the edges of the city. This has traditionally been used to channel growth in certain directions. When a citizen has been grated a plot of land, he/she is not required to build on it. Recipients tend to

retain the land until the value increases, thus contributing to the amount of white lands (Telmesani, n.d.). It is typically only the low-income citizens who build on their land after obtaining the Real estate Development Fund, in order to take advantage of the fund. Sprawl then continues further out from the city center.

Real Estate Development Fund

Another factor related to continued sprawl in Riyadh is the government's Real Estate Development Fund (REDF), implemented in 1970 with a capital of $71 million (Al-Hathloul & Edadan, n.d.). The REDF is a long-term interest-free loan intended to boost home ownership, and consequently the housing market. Basically, Saudi citizens who already have land, either bought or granted, receive these loans to aid in building their homes. These loans are available to Saudis of all income levels, with differing values depending on the area (Telmesani, n.d.). Additionally, after obtaining the REDF, this loan can be used to build a house on a different plot owned by the applicant. However, it is required that construction commence soon after receiving the loan.

The only issue with this is that it encourages each family to own a home, greatly increasing the need for available land space. Unlike the land grant system, the REDF does not allow for direct control over the location of development, but instead only impacts the amount of development. Since applicants must already have land in order to apply for the REDF, low-income individuals often seek cheap land further from the city center to build their homes on. This tendency to locate in the outer suburbs has resulted in a great deal of leapfrogging and low-density development (Telmesani, n.d.).

Furthermore, this sprawl has occurred in a manner that has increased social segregation. The concentration of governmental and private institutions in the northern areas of the city has channeled a certain degree of growth to that area. However, since the northern area is thought of as a prestigious region of Riyadh, land values are high and only the rich can afford to purchase land there. The southern areas are more affordable for the less fortunate. Therefore, sprawl occurs in a north-south pattern, with the wealthy in one region and the poor in another. This socio-economical segregation was not present during the period when Riyadh was a walled city (Telmesani, n.d.).

Privacy

Privacy has also been a major factor shaping the urban form of the city, including the pattern of sprawl. In Saudi Arabia, the public and private spheres are highly separated. The majority of residential dwelling units are villas with 2.5 meter-tall solid fences surrounding them for privacy. Additionally, owners typically install non-transparent glass on their windows so that neighbors cannot see inside the home from the second floor. It is also not uncommon for Saudis to purchase land adjacent to their homes, consequently contributing to increasing white lands. This serves two purposes. First, it provides more freedom for families. They can leave their windows open and enjoy being outdoors without being seen, heard, or disturbed by neighbors. Second, it could serve as a residential location for adult children, which parents prefer live next to them. Having relatives next door would alleviate privacy concerns as well (Alskait, 1993). The focus on privacy in Saudi Arabia prevents Saudis from wishing to live in apartments, tall buildings, or otherwise high-density locations, as this would mean sacrificing privacy.

Car Dependency

Riyadh residents are highly dependent upon cars in their daily commute. In 1996, 85 percent of daily trips were made by automobile, constituting 4.5 million daily trips (ADA, 2004). In 2010, this number has increased to 6 million daily trips (ADA, 2010). The movement of people to the outer edges of the city has resulted in an ever-increasing need for automobiles. The development of high-quality highways has perpetuated the dominance of car culture. With gas prices among the lowest in the world, operating cars is significantly more affordable than in other nations. Furthermore, car purchases are not taxed, and insurance requirements are fairly relaxed.

Most plans proposed for potential future public transportation are problematic due to the strict gender separation implemented by the country's religious laws. Women and men could not feasibly use the same public transportation. Even if there were separate buses or trains for men and women, they would still be gathered in the same general loading areas. Riyadh is also not a pedestrian-friendly location, as it lacks shaded walkways, sidewalks, and a city layout encourages to frequent walking. When cars dominate, sprawl is enhanced. The benefits of high-density development are often minimized when driving is so easy.

Planning Policies

Riyadh is one of the most rapidly growing cities in the Middle East, and sprawl is occurring at an alarming rate. However, the city's plans do not currently emphasize the importance of limiting sprawl. There have been minimal efforts made to minimize the effects of sprawl, but the root causes of sprawl have not yet been fully addressed. Although the city has outlined growth boundaries, new plans for constructing additional

ring roads further outside of the city are in direct opposition to the boundary purpose. It seems that current plans are continuing to support problematic sprawl.

Riyadh has maintained a centralized pattern of development over the years where the CBD and public services were located in the city center. Due to the horizontal expansion of the city, the city center has become very crowded. As a result, the government has recognized potential benefits in developing five sub-centers to decentralize this massive concentration from the city center (see Figure 12). These sub-centers are to be located in the periphery of the city, about 25 kilometers from the city center. Most of these locations are between 90 and 100 percent vacant (ADA, 2005).

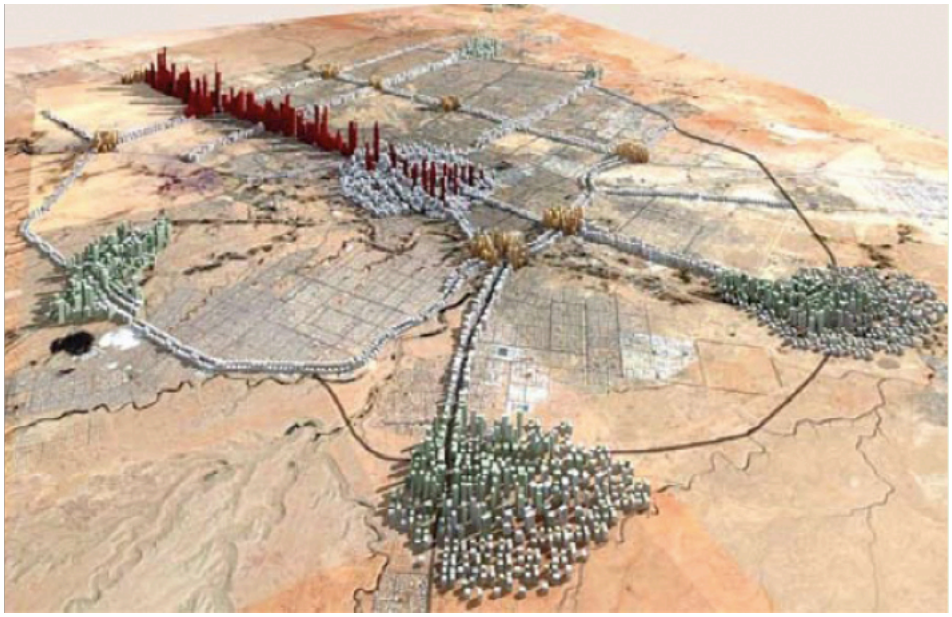

Figure 12: Rendering of the future decentralized sub-centers in Riyadh. Adapted from Arriyadh Development Authority. "Future sub-centers" [Image]. In: Total strategic plan for Riyadh city: Sub-centers (in Arabic), n.d., p.7. Retrieved Feb 10, 2010, from: http://www.arriyadh.com/ar/cgibin/booklet/?get=/AlMarakizAlFariyagrowth.pdf

The future sub-centers are planned to be high-density mixed-use urban hubs ranging between 2 to 2.5 square kilometers to accommodate a population of up to one million persons within a 20-kilometer radius. These hubs would provide job opportunities, branches of government institutions, housing, recreational facilities, and commercial services. This would reduce the need to commute to the major city center. These sub-centers are to be connected with the city center through a future public transportation system (ADA, 2004).

In an unprecedented process, the private sector is currently developing the above-mentioned sub-centers. Private developers are responsible for the infrastructure construction. In order to encourage private developers and investors, no restrictions have been placed upon the height of buildings within the core of sub-centers. The Arriyadh Development Authority is currently in the process of receiving development proposals from several private developers in order to choose the best match with the expected development (ADA, 2004).

Riyadh's plan has also designated two areas for future satellite towns in the north and east. These areas are located 40 kilometers from the city center (see Figure 13). These towns are planned to be reserved for extensive, unexpected population growth. As shown in Figure 14, these satellite towns are currently located within the urban limits through 2021, at which time they could be left undeveloped if the population growth remained at reasonable levels. These satellite towns, if developed, would have their own distinctive character compatible with the location (ADA, 2004).

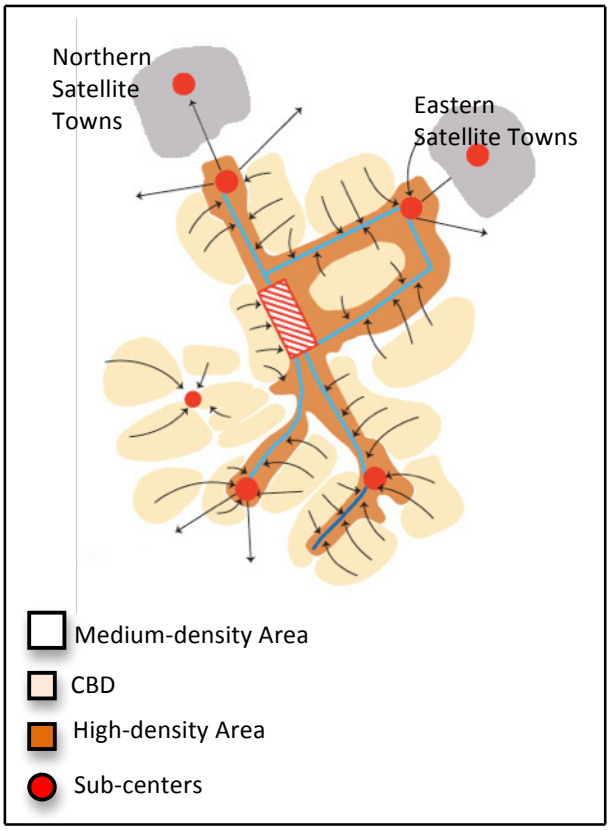

Figure 13: Decentralizing approach through sub-centers and satellite towns. Adapted from Arriyadh Development Authority. "The relationship between the new sub-centers and activity corridors)" [Diagram]. In: Total strategic plan for Riyadh city: General structural plan (in Arabic), 2004, p.67. Retrieved Feb 10, 2010, from: http://www.arriyadh.com/ar/cgi bin/ booklet/?get=/AlMokhatatAlHaklyAlAam

The transportation element of Riyadh's plan suggests developing a reliable public transportation system to reduce reliance on cars, even with the above-mentioned issue of gender restriction. It is unknown how this will operate in coordination with gender segregation. The plan has recommended a light-rail and bus system. The light-rail system is currently under construction on a north-south and east-west axis. The rail system will serve residents commuting to the city center, and will also connect sub-centers. The plan also emphasizes expanding current roadway capacities, although this is a known contributor to increased sprawl. It is estimated that this new roadway

construction will double the capacity of daily vehicles from 5 million to 11 million (ADA,2004).

The environmental element highlights the importance of reducing the causes of environmental degradation. Regarding water sources, it is recommended that private developers establish a sewer system in their developments instead of the current septic tank systems most commonly used. This is intended to reduce groundwater contamination. Also, it is suggested that the practice of dumping waste in the valley be prohibited. The environmental element highlights the importance of public awareness in reducing excessive water use and introducing the concept of recycling. Regarding air quality, the plan takes an optimistic approach in assuming air quality will be significantly improved by the introduction of a public transportation system (ADA, 2004).

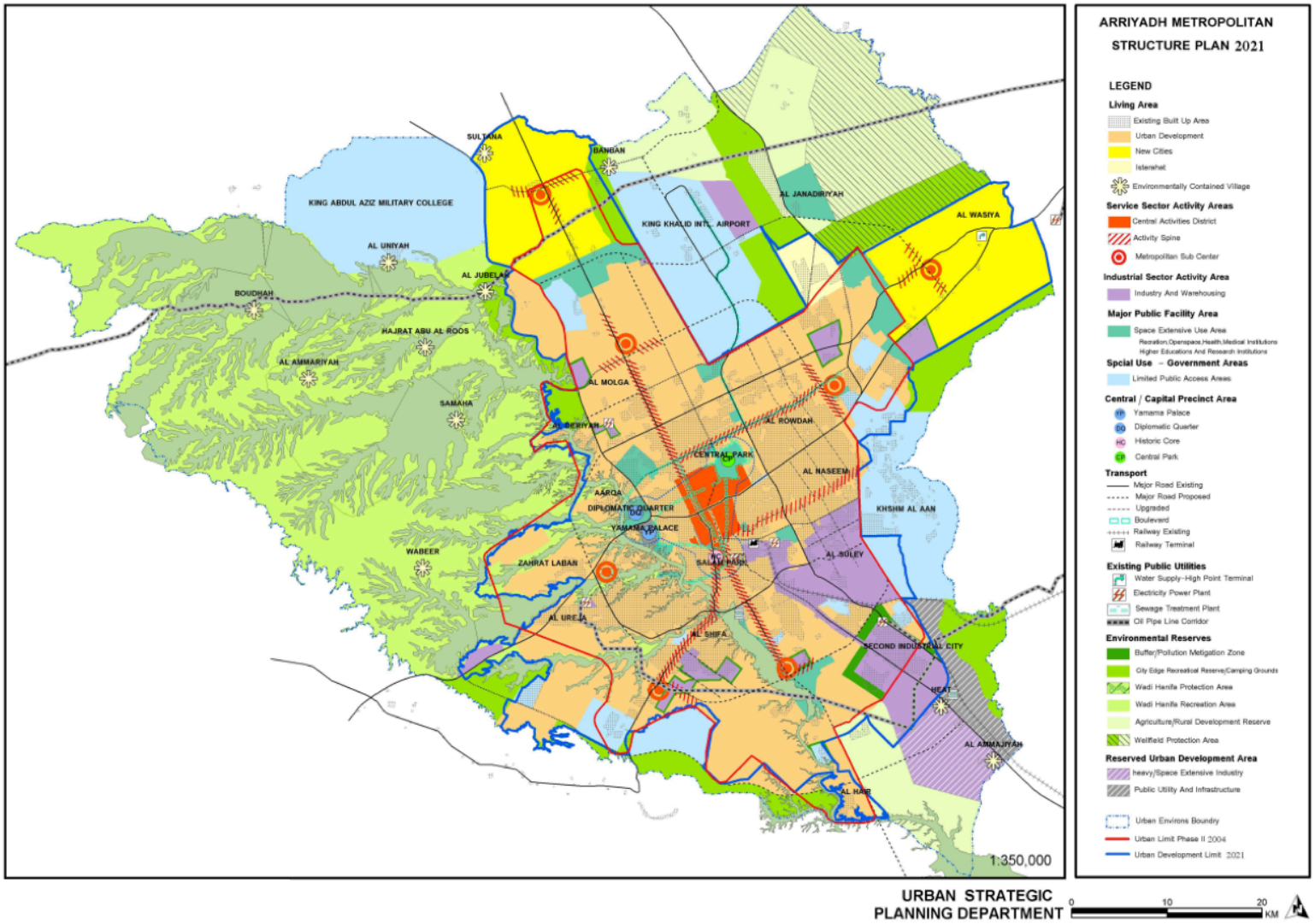

Figure 14: Riyadh's plan showing the urban development limit of 2021. Adapted from Arriyadh Development Authorety. "Arriyadh metropolitan structure plan 2021" [Map]. 1:350,000. In: The vision for the new suburban cities: Executive summary. Riyadh: Saudi Arabia: The High Commission for the Development of Arriyadh, 2004, p.5.

Analysis and Findings

Case Study Comparison

In both case studies, persistent sprawl is a relatively recent phenomenon. Unlike other cities impacted by industrialization, desert cities were primarily affected by the advanced technologies that have made living in the desert more desirable, with running water, air conditioning, and other amenities. Desert cities have transitioned from reliance on natural available resources to reliance on the technologies providing them with convenient living. The case studies have demonstrated how creating an artificial living environment through excessive resource consumption is unsustainable over time.

The recent unprecedented population growth in both Phoenix and Riyadh was a major cause of sprawl in these cities. In both cities, this growth was once viewed positively. In Phoenix, population growth was viewed favorably because it generated additional tax revenue. In Riyadh, growth was viewed favorably because it was aiding in the establishment of a modern capital city capable of competing with other world capitals.

The automobile, along with roadway construction, was a key sprawl contributor in both cases. Unlike Phoenix, Riyadh residents' reliance on cars is a matter of necessity rather than luxury. Due to the large typical family size in Saudi Arabia, cars make commuting as a family fairly convenient. Also, due to the current lack of sidewalks and

public transportation, the car serves as the only suitable mode of transportation to many places.

Two patterns of sprawl can be observed in these case studies. The sprawl in Phoenix is radial, expanding in each direction away from the urban core. "White flight" has left a predominately poor population in the center, and a wealthier population around the city's edges. Riyadh's sprawl is axial, expanding primarily to the north and south directions of the city center. In this case, the wealthier are located in the more expensive northern region, where government offices and key businesses are established, and the less fortunate reside toward the southern region of the city. Socio-economic segregation in Phoenix is a result of choice, whereas this segregation in Riyadh results from public policies and land value.

In fighting sprawl, there were some similarities and differences in both case studies. Both have responded to horizontal expansion by identifying multiple nodes for planned developments to cluster around. The 14 urban villages of Phoenix and the 5 sub-centers in Riyadh are relatively similar in that they both encourage high-density developments and public transportation. A key difference between them is that Phoenix' urban villages are being developed on land already significantly inhabited. Riyadh's sub-centers are currently 90 to 100 percent vacant. Rather than concentrating developments around already built areas, the sub-centers of Riyadh will create new nodes for leapfrogging to occur.

While both cities have a growth boundary, annexation may be problematic when used in Phoenix. While the Saudi government owns most lands outside the boundary, there would be no conflicts occurring for implementing the city's plan. In Phoenix, there

are many vacant lands adjacent to the city that could be obtained through annexation. However, these lands may not be compatible with the city's plan because they could result in unpermitted uses in Phoenix and might have different setbacks (City of Phoenix, 2002) .

Phoenix seems to be more aware of the environmental impact of current development pattern. Their plan has tackled the urban heat island issue along with the need of using alternative fuel sources. Phoenix's plan, however, raise the issue of "public acceptability" while presenting conservation policies. It seems that the idea of conservation, especially on water use, would be difficult. Even though voters have agreed to pay more taxes to preserve natural land, changing the current life style of living seems more difficult since it is the lifestyle that brought most of them to the region. Whereas in Riyadh, the top-down decision making process makes implementing rational planning decisions fairly easy.

Lessons Learned

It is obvious that the patterns of development demonstrated by the desert city case studies of Phoenix and Riyadh are not sustainable over time, as their environments are largely artificial. They are the creation of modern technologies. Unprecedented expansion has occurred in both cities within the past few decades, transitioning these areas from largely desert lands to very large metropolises.

It appears that city plans for these case studies currently do not work to use the environment in the best possible way for planning. Older desert settlements could serve as valuable resources in planning and architecture to best maintain desert cities. Surely

there are ways to develop older adaptability concepts in a manner compatible with the 21st century to create more sustainable desert cities.

Natural ventilation could reduce reliance on electricity for air conditioning, and inner courtyards could permit residents to maintain pleasant outdoor areas. This also serves as a land preservation tool, as being introverted allows for utilizing the total lot area. Courtyards have long been used successfully in many desert city buildings, including some college buildings within Arizona State University.

The pattern of sprawl results from citizens' preferences. People have made the decision to reside in periphery locations, searching for better quality of life. However, these individual preferences have caused the whole community to suffer. The negative impacts are seen in unjustified infrastructure expenditures, environmental degradation, and an aesthetically unpleasant urban structure. Most developments were legally created, not violating their zoning codes. Involving the public in decision-making processes may not only increase citizens' awareness of the negative impacts of current development and living patterns, but might also shift development from being market-driven to being more rationally planned.

As previously mentioned, people react and behave based on available tools. If highways and interstates are constructed, people will use them. Similarly, when an area lacks sidewalks, people are far less likely to walk to their destinations. In desert cities, however, sidewalks alone are not sufficient enough to increase pedestrian flow. Understanding the surrounding environment and observing old desert city patterns will lead to the conclusion that shade is a crucial factor when using sidewalks. Moreover, providing shaded sidewalks should not consist of simply implanting trees, which requires

more water for irrigation. The entire urban fabric and development pattern should work together as a system for desert cities to be sustainable.

Most residents in these desert cities are migrants from different regions, and perhaps from different countries. Cheap water, gas, and electricity prices have shaped their pattern of consumption. When services are available and affordable, people's attitude toward them would dramatically change as well. The public should be educated about the lack of resources the desert has to give.

Regarding increasing density, one study compared the suburban settlement pattern in North America with different compact forms in Asia and the Middle East. Schnauer (1981) found that in North American suburbs only one sixth of the total land area is being used for dwelling (17 percent), as opposed to two thirds in compact forms (Schnauer, 1981). This study demonstrates that increasing density is possible without the need for building high rises.

Desert cities should develop innovative solutions to reducing current patterns of land and natural resource consumption. Riyadh, for example, depends on economical support from oil revenue, which was a major factor in creating the city. However, someday this oil will run out. The problem of resources becoming increasingly scarce is an issue for all desert cities. Since bringing electric energy to far-out city suburbs is problematic for several reasons, efforts should be made to harness natural resources such as the blazing desert sun for energy. "Truly, we pay a stiff energy cost for our isolation, for the form and function of our cities, and for the prospect that the situation will not improve until we adjust how we live." (Pasqualetti, n.d., pp.161-162).

Finally, while growth is viewed positively in many cities, is there a point where growth should be stopped? A common practice among sprawling desert cities is to create a problem, then try to solve its negative outcomes. This is simply not practical. Negative impacts are already being seen. However, the real negative impact is still to come as both natural resources and available land space become increasingly scarce.

Conclusion

The case studies of Phoenix and Riyadh allow for a great deal of learning about the concept of urban sprawl, particularly in desert cities. Both cities have experienced rapid growth and sprawl. Development patterns have both resulted in and been the result of economics, public policies, and citizen preferences. If anything is to change, the various forces involved in the sprawling development of cities must be clearly understood. A city's particular circumstances, including the culture and wishes of those living in the area, should be taken into consideration in developing more reasonable solutions to the key issue of sprawl.

While city governments work to reduce sprawl, they also unintentionally perpetuate this harmful development pattern. It can be seen that both cities' governments are influencing sprawl as much as they are trying to solve it. While their plans aim to increase density, encourage mixed-use developments, and promote public transportation, highways are sill being constructed, single-use zoning ordinances are still permitted, and land is being utilized in an unsustainable manner. These governmental policies, which encourage sprawl, they cause sprawl-reduction plans to become nearly impossible to successfully implement.

It is possible to live well with less, even in the desert. Although desert cities often encourage horizontal expansion with their wide-open spaces, it is possible to reduce sprawl and develop in a sustainable manner only if sprawl contributing factors have been reduced. While the desert presents significant limitations, in terms of natural resources, it also provides for ample opportunities in good planning. With hard work and dedication, surely something can be done to limit sprawl in these troubled cities.

Bibliography

Al-Fouzan, S. (1995). Reducing car-dependence in Ar-Riyadh city through the integration of land-use planning and transport. Unpublished doctoral dissertation, University of Stratclyde, Glasgow, United Kingdom.

Al-Hathloul, S. & Edadan, N. (n.d.) Housing needs and housing development alternatives. In Al-Hathloul, S. & Edadan, N. (Ed.), *Urban development in Saudi Arabia: Challenges and opportunities* (pp. 157-178). Riyadh: Dar Al Sahan.

Al-Khalifah, A. (n.d.) Urban social structure. In Al-Hathloul, S. & Edadan, N. (Ed.), *Urban development in Saudi Arabia: Challenges and opportunities* (pp. 89-112). Riyadh: Dar Al Sahan.

Alskait, K. (1993). *Ring road development and vacant lands: Riyadh, Saudi Arabia*. Unpublished doctoral dissertation, University of British Columbia, Canada.

Arriyadh Development Authority. (2004). *Conceptual structure plans for five metropolitan sub-centers in Arriyadh*. Riyadh: Saudi Arabia: The High Commission for the Development of Arriyadh.

Arriyadh Development Authority. (2004). *The vision for the new suburban cities: Executive summary*. Riyadh: Saudi Arabia: The High Commission for the Development of Arriyadh.

Arriyadh Development Authority. (2004). *Total strategic plan for Riyadh city (in Arabic)*. Retrieved Feb 10, 2010, from http://www.arriyadh.com/ar/StrPlan2 /index.aspx

Arriyadh Development Authority. (2005). *Analytical studies of the field survey of Riyadh city:Third report, Executive summary.* Riyadh, Saudi Arabia: Tanmeyah for engineering consulting. Retrieved from http://www.ada.gov.sa /ar/Researches/index.aspx

Burgess, P. (1998). *Revisiting "Sprawl": Lessons from the Past*. Retrieved Feb 9, 2010 from: http://urban.csuohio.edu/research/pubs/resprawl.pdf

Calthorpe, P. (1989). The Pedestrian Pocket. In Richard LeGates and Fedric Stout (Ed.), *The City Reader*- Second Edition (pp. 350-356). London: Routledge.

City-data (2008). Retrieved May 27, 2010 from http://www.city-data.com/

City of Phoenix. (2002). *Phoenix general plan*. Retrieved Feb 10, 2010, from: http//phoenix.gov.PLANNING/gpindex.html

Cram, B. & Lay, T. (Director/Producer), Cram, B., Lay, T. & Majoros, M. (Writers) (2003). Phoenix: The urban desert [DVD]. Northern Light production in collaboration with the Lincoln Institute of Land Policy.

Fainstein, Susan, and Campbell. (2002). Introduction: Theories of Urban Development and Their Implications for Policy and Planning. In Susan Fainstein and Scott Campbell (Ed.), *Readings in Urban Theory*—Second Edition (pp. 1-15).

Fishman, R. (1989). Bourgeois Utopias: Visions of Suburbia. In Susan Fainstein and Scott Campbell (Ed.), *Readings in Urban Theory*—Second Edition (pp. 21-31).

Golany, G. (1983) Urban form design for arid regions. In Golany, G. (Ed.), *Design for arid regions* (pp. 1-23). New York: Van Nosrand Reinhold Company.

Goldsmith, W. (2000). From the Metropolis to Globalization: The Dialectics of Race and Urban Form. In Susan Fainstein and Scott Campbell (Ed.), *Readings in Urban Theory*—Second Edition (pp. 129-149).

Heim, C. E. (2001). Leapfrogging, urban sprawl, and growth management: Phoenix, 1950-2000. *The American journal of economics and sociology*, 60, 245-283.

Kahn, M. (2006). *Green cities: Urban growth and the environment*. Washington, DC: Brookings Institution press.

Kelly, E. (2004). *Managing community growth* (2nd Ed.). Westport, CT: Praeger Publishers.

Kenworthy, J. Jr. (2003). *Transport energy use and greenhouse gases in urban passenger transport system: A study of 84 global cities*. Retrieved from the University of Winnipeg, Center for sustainable transportation website: http://cst.uwinnipeg .ca/documents/Transport_Greenhouse.pdf

Meunier, J. J. (n.d.) Making desert cities. In Lusk, P. & Simon, A. (Ed.), *Building to endure: Design lessons of arid lands* (pp. 61-88). The University of New Mexico Press.

Morrison Institute for Public Policy (2000). *Hits and misses: Fast growth in metropolitan Phoenix*. Retrieved March 27, 2010 from Solimar research group website http://www.solimar.org/pdf/hitsandmisses.pdf

Mubarak, F. (n.d.) The role of state in shaping urban forms. In Al-Hathloul, S. & Edadan, N. (Ed.), *Urban development in Saudi Arabia: Challenges and opportunities* (pp. 247-285). Riyadh: Dar Al Sahan.

Pasqualetti, M. J. (n.d.) Energy landscape and the growth of Arizona. In Lusk, P. & Simon, A. (Ed.), *Building to endure: Design lessons of arid lands* (pp. 155-180). The University of New Mexico Press.

Rex, T.R. (2000). *Development of metropolitan Phoenix: Historical, current and future trends*. Retrieved from the University of Arizona, Center for business research website: http://wpcarey.asu.edu/seidman/ccpr/PDFs/development .pdf

Rex, T.R. (2000). *Population density in metropolitan Phoenix*. Retrieved from the University of Arizona, Center for business research website: http://wpcarey .asu.edu/seidman/ccpr/PDFs/density.pdf

Schipper, J. (2008). *Disappearing desert: The growth of Phoenix and the culture of sprawl.* Norman, Oklahoma: University of Oklahoma press.

Schoenauer, N. (1981). *6,000 years of housing*. New York: Garland STPM Press.

Simon, A. J. (n.d.) Water, culture, and values. In Lusk, P. & Simon, A. (Ed.), *Building to endure: Design lessons of arid lands* (pp. 135-153). The University of New Mexico Press.

Smith, N. (1986). Gentrification, the Frontier, and the Restructuring of Urban Form. In Susan Fainstein and Scott Campbell (Ed.), *Readings in Urban Theory*—Second Edition (pp. 129-149).

Telmesani, A. (n.d.) Urban structure and determinants of residential location: A case study of Riyadh. In Al-Hathloul, S. & Edadan, N. (Ed.), *Urban development in Saudi Arabia: Challenges and opportunities* (pp. 179-213). Riyadh: Dar Al Sahan.

Travis, W. (2007). *New geographies of the american west: Land use and the changing patterns of place*. Washington, DC: Island press.

Torrens, P. (2006). Simulating Sprawl. *Analysis of the Association of American Geographers.* 96 (2), p248-275.

United Nations. (1992). *Adoption of agreements on environment and development: agenda 21*. United Nations conference on environment and development, Rio de Janeiro: 3-4, June, 1992. A/CONF.151/4 (Part1), Chapter 12,12.2. Retrieved from: http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm

U.S. Census Bureau. (2000). *Ranking tables for metropolitan areas: 1990 to 2000.* Retrieved June 4, 2010, from http://www.census.gov/population/cen 2000/phc-t3/tab05.txt

U.S. Census Bureau. (2010, April 22). *State & county Quickfacts: Maricopa County, AZ.* Retrieved June 12, 2010, from http://quickfacts.census.gov/qfd/states/04/0455000.html

Williams, D. (2000). *Urban sprawl: A reference handbook*. Santa Barbra, California: ABC-CLIO, Inc.

World Energy Source (July, 2008). *World energy monthly review*. Retrieved from: http://www.worldenergysource.com/wes/stores/1/July-2008-C26.aspx